Section 4
Maintenance

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CAUTION

The installation and servicing instructions in this manual are for use by qualified personnel only. To avoid electric shock do not perform any servicing other than that contained in the Operating Instructions unless you are qualified to do so. Refer all servicing to qualified service personnel.

Routine Maintenance

The 9105A OPTIMOD-HF Audio Processor is a highly stable device which uses solid-state circuitry throughout. Recommended routine maintenance is minimal.

1) Periodically check VU and gain reduction meter readings.

Become familiar with normal VU meter readings, and with the normal performance of the G/R meters. If any meter reading is abnormal, see Section 5 for troubleshooting information.

2) Listen to the 9105A's output.

A good ear will pick up many faults. Familiarize yourself with the "sound" of the 9105A as you have set it up, and be sensitive to changes or deteriorations. If problems arise, please don't jump to the conclusion that the 9105A is at fault. The troubleshooting information in Section 5 will help you determine if the problem is with OPTIMOD-HF or is somewhere else in the station's equipment.

3) Periodically check for loss of grounding.

Check for loss of grounding due to corrosion or loosening of rack mounting screws.

Particularly in humid or salt-spray environments, check for corrosion at the input and output terminals and at those places where the 9105A chassis contacts the rack.

4) Clean the front panel when it gets soiled.

Wash the front panel with a mild household detergent and a damp cloth. Stronger solvents should not be used because they may damage plastic parts, paint, or lettering (99% isopropyl alcohol can be safely used).

Routine Performance Verification

There are no quick, definitive instrument tests of OPTIMOD-HF performance that can be done with ordinary program material. Your ear is the best test instrument. However, there is a simple pink noise test to evaluate some of the more important 9105A performance parameters. You may want to make this part of your routine equipment testing.

1) Obtain reference G/R for later use in routine testing.

This procedure requires you to record the normal indication of each of the MULTI-BAND LIMITER G/R meters when the 9105A is driven by a standard signal (pink noise), and adjusted for normal operation. These indications can be used for testing later: if any indication has changed, this implies that either the 9105A has developed a fault, or its setup controls have been re-adjusted.

Record the reference meter readings for this test immediately after installation, and again whenever you change the 9105A's control settings.

A☐ Take the 9105A off the air.

B☐ Connect a pink noise generator to the 9105A's INPUT terminals.

C☐ Adjust the level of the pink noise until the BROADBAND AGC G/R meter reads "0".

D☐ Record the reading of MULTI-BAND LIMITER G/R meters.

E☐ Record the reading of the VU meter for each position of the rotary selector switch.

F☐ Return OPTIMOD-HF to the air.

2) Routine performance test: check meter readings with pink noise input.

A☐ Take the 9105A off the air.

Although this test can be completed in less than one minute, alternate processing should be switched on-line temporarily (unless you are willing to broadcast pink noise!).

B☐ Connect a pink noise generator to the 9105A's INPUT terminals.

C☐ Adjust the level of the pink noise until the BROADBAND AGC G/R meter reads "0".

D☐ Verify that the readings of the MULTI-BAND LIMITER G/R meters, and of the VU meter, match the reference levels recorded in step 1.

If not, either someone has changed the control settings or a fault has developed in the 9105A circuitry. See the troubleshooting information in Section 5.

E☐ Return OPTIMOD-HF to the air.

Getting Inside the Chassis

- Access **set-up controls** by opening the small door on the 9105A's front panel with the supplied key.
- Access the **AC POWER and VOLTAGE SELECTOR switches, and the fuse** by opening the 9105A's front panel (see page 4-5).
- Access the **circuit cards** by opening the 9105A's front panel, then removing the subpanel (see page 4-5). Always turn off AC power before removing or replacing circuit cards.

Set-up, adjustment, and alignment of the 9105A requires access only to the front and rear panels and to those interior parts of the unit behind the front panel and subpanel. Almost all servicing can be done without removing either cover.

One exception is the +15V power supply voltage adjustment, which requires removing the top cover.

Further disassembly of the 9105A may be required for some service procedures.

For access to:	See page:
Behind front panel	4-5
Behind subpanel	4-5
Behind rear panel	4-6
Input Filter board	4-7
Unregulated power supply chamber	4-7
Power transistors, Card #PS (power supply regulator)	4-8

For best RFI protection, replace *all* screws and tighten them firmly. If screws are lost, replace them with screws of the same length (longer screws may cause mechanical interference or internal short circuits). Most screws used in the 9105A are undercut binding head for secure fastening without lockwashers (if a pan head screw is substituted, use an internal-star lockwasher). All screws are steel, plated with zinc (type II).

Front panel — open and close.

To open:

1) Close and lock the access door.

2) Remove the 2 hex-socket screws at the top of the front panel with a 5/64-inch hex wrench (provided with the unit), then slowly tilt the hinged front panel downward to reveal the interior.

To close:

1) Replace the subpanel if it has been removed.

   See below. *The subpanel should always be replaced*, since it is an integral part of the chassis RFI protection.

2) Check that the internal AC POWER switch is set to ON.

3) Raise the front panel and fasten the 2 screws that secure it in place with the 5/64-inch hex wrench provided with the unit.

Subpanel — remove, replace.

To remove:

1) Open the front panel (see above).

2) Loosen the four DZUS fasteners on the subpanel by turning each fastener 1/4-turn counterclockwise with a long 3/16- or 1/4-inch (6mm) flat-blade screwdriver.

3) Taking care not to stress the flat cables beneath it, tilt the top of the subpanel outward and to the left to clear the upper chassis lip and the door support rail at the right.

To replace:

The subpanel should always be replaced, since it is an integral part of the chassis RFI protection.

1) Taking care not to stress the flat cables beneath it, position the subpanel.

   Tilt the top of the subpanel inward and to the left to clear the upper chassis lip and the door support at the right.

2) Turn the DZUS fasteners 1/4-turn clockwise with a long 3/16- or 1/4-inch (6mm) flat-blade screwdriver.

   The DZUS fasteners turn only 1/4-turn. Don't force them — they can be damaged in a way that is very time consuming to repair.

Rear panel — remove, replace.

To remove:

1) Disconnect the 9105A and remove it from the rack.

   It is not practical to remove the rear panel when the 9105A is mounted in a rack.

   If the covers are in place, they don't need to be removed.

2) Remove the 8 screws holding the top cover to the flange of the rear panel. Also remove the 8 screws holding the bottom cover to the rear panel.

   The rear panel will remain solidly in place.

3) Set the unit upright on a padded surface, with the rear panel facing you.

   Leave about 6 inches (15 cm) between the rear panel and the edge of the table. Be sure the AC power cord is unplugged.

4) Remove the 3 groups of 3 screws *circled in black* on the rear panel.

5) *Very carefully* pull the rear panel about 3/4-inch (2cm) toward you, and then tilt the top of the rear panel down until the rear panel is horizontal.

   Careful! Watch for snags in the wiring or stress to the ceramic capacitors on the internal divider wall or RFI shielding box. These capacitors are very fragile and are difficult to replace.

To replace:

1) *Very carefully* tilt the rear panel up until it is vertical, and then push the rear panel forward into place.

   Take care that no wires are pinched between the panel and the chassis.

2) Replace the 9 screws in the 3 groups of 3 screw holes circled in black on the rear panel. Also replace the 16 screws that attach the top and bottom covers to the rear panel.

   Do not tighten any screws until all screws are loosely in place.

3) Return the 9105A to its rack, connect and ground unit.

Input filter board, RFI shielding box — remove, replace.

To open RFI shielding box and remove input filter board:

1) Open rear panel.

See page 4-6.

2) Remove the 4 screws that hold the large, shallow, metal RFI shielding box to the inside of the rear panel.

3) Carefully remove the cover to reveal the input filter circuit board.

Careful! Watch for snags in the wiring or stress to the ceramic capacitors on the internal divider wall or RF shielding box. These capacitors are very fragile and are difficult to replace.

4) This will reveal the internal circuit card, which is attached to the rear panel by four # 4-40 screws and by the tails of the barrier strips which are soldered to the card. Removing this card for component replacement requires unsoldering all of the tails of the barrier strip from the circuit card, as well as removing the four screws holding the filter box. This is tedious. Instead, we suggest clipping out the defective component from the top side of the card and installing its replacement by tack-soldering to the old leads. If done carefully, this procedure can be adequately reliable as long as the chassis is not subject to severe vibration.

To replace input filter board and RFI shielding box:

1) Position the metal RFI shielding box so the screw holes in its flanges line up with the screw holes in the rear panel.

Take care that no wires or components are pinched between the panel and the chassis. Dress wires appropriately.

If components have been replaced, make sure that reassembly will not crush or otherwise damage the components.

2) Replace the 4 screws that attach the RFI shielding box to the rear panel.

3) Close the rear panel.

See page 4-6.

Left side panel — remove, replace.

[Remove the left side panel to access the mains and raw DC power chamber.]

Be sure that the AC power is disconnected.

To remove:

1) Open the front panel (see page 4-5).

2) Remove the shoulder screw that attaches the door-support rail at the left.

Note that there is a nylon washer between the rail and the side panel to prevent scraping.

3) Close the front panel and fasten it with the center screw *only*.

4) Turn the chassis so that the left rack flange faces you.

5) Remove the 5 screws that attach the top cover to the top of the left side panel. Also remove the 5 screws that attach the bottom cover to the left side panel.

The left panel is to the left as you face the front of the unit — the side nearest the VU meter.

6) Remove the 3 circled screws on the rear panel that attach it to the left side panel.

7) Remove the 6 recessed screws on the left side panel.

8) Gently pull the side panel toward you and remove it.

To replace:

1) Position the left side panel and start (*but do not tighten*) the 6 recessed side-panel screws.

Make sure the door support rail is positioned properly in its slot.

2) Replace (*but do not tighten*) the 3 circled screws that attach the rear panel to the side panel.

3) Replace (*but do not tighten*) the 5 screws that attach the top cover to the top of the left side panel. Also replace the 5 screws that attach the bottom cover to the left side panel.

4) Tighten all 19 screws.

5) Open the front panel (see page 4-5), and replace the shoulder screw.

Be sure to position the nylon washer next to the left side panel.

6) Close the front panel (see page 4-5).

Power transistors, Card #PS — remove, replace.

To remove:

Because removal of Card #PS is difficult, the card has been designed to permit many servicing operations to be performed *without* removing the card from the chassis. IC chips are in sockets. Many of those components which are not mounted in sockets can be replaced from the top of the card by tack-soldering the new component to the lead stubs of the old, clipped-out component.

If Card #PS *must* be removed, follow these instructions carefully.

CAUTION

The rear panel is a heat dissipator for the power transistors. Proper contact is necessary to ensure sufficient transistor cooling.

1) Remove the 4 press-fit plastic plugs inside the recesses on the power transistor covers, using a pair of chain-nose pliers.

2) Loosen the 2 screws that attach each power transistor.

   These screws have captive nuts that will not fall into the chassis.

3) Remove the transistor covers and the associated screws and lockwashers from the rear panel.

4) Mark each transistor case to indicate the transistor's location and orientation.

5) *Very carefully and slowly* pull each transistor from its socket.

   If the silicone rubber insulator sticks to the panel, release it from the panel so that it sticks to the bottom of the transistor instead. After you remove each transistor, press its insulator back in close contact with the transistor.

   These insulators form themselves to the bottom surface of each transistor. Since they take a "set", they should not be interchanged or reversed.

6) Open the rear panel (see page 4-6).

7) Release Card #PS from its plastic post mounts by squeezing the tangs at each corner of the card, then pull the card off the posts.

To replace:

1) Replace Card #PS onto its plastic post mounts by pressing it over the 4 tangs at each corner of the card.

   Verify that the transistor sockets are aligned so that they seat in the rear-panel holes.

2) *Very carefully* reinstall the power transistors in their sockets.

   Be careful to replace the transistors in the same positions from which they were removed (refer to the marks made on the transistor cases during removal). Verify that the sockets are exactly aligned in the holes.

   The transistor insulators should not have been interchanged or reversed. If you must replace a power transistor, re-use the insulator if it is in good condition. With care, it will re-form itself as necessary. Otherwise, use a conventional mica insulator and white silicone heat-conducting compound.

3) Insert the screws and lockwashers in the transistor covers, and position them over the transistors.

   There *must* be a *split* lockwasher under the head of each screw to accommodate thermal cycling.

   These plastic covers do not attach in a conventional or readily obvious way. They ride on the circumference of the special split lockwasher and do not (and should not) become captured under the head of the screw. Consequently, the cover may be slightly loose even after screws are tightened securely. This is normal — do *not* try to "correct" it.

4) Tighten the screws.

   The screws mounting the transistors should be tightened *evenly*. For best thermal contact, tighten each screw a small amount, alternating between screws. Tighten securely, but not enough to damage the threads in the sockets.

5) Replace the 4 press-fit plastic plugs in the power transistor covers.

6) Close the rear panel (see page 4-6).

System Performance Measurements

Often, a broadcasting authority will wish to perform tests of the transmission plant by remote control. OPTIMOD-HF has a PROCESSOR NORMAL/BYPASS function, selectable from the front panel or by remote control, to accomplish this easily. When set to BYPASS, most of the OPTIMOD-HF circuitry is bypassed, but a 50Hz high-pass filter, 4.5kHz low-pass filter (or other cutoff frequency as ordered), and safety clipper remain in-circuit to protect the transmitter.

OPTIMOD-HF is also equipped with a PROCESSOR NORMAL/AGC-CLIPPER DEFEAT switch (on the sub-panel) that facilitates testing the *processor circuitry alone* by defeating all gain reduction and clipping, but not bypassing any circuitry.

This test mode is not useful for automated testing of the system because:

1) The PROCESSOR NORMAL/AGC-CLIPPER DEFEAT switch cannot be operated by remote control, and

2) Some bass clipping is retained even in test mode. This requires the 9105A's OUTPUT ATTENUATOR to be readjusted to achieve 100% modulation at low frequencies.

A comprehensive procedure for bench-testing the 9105A (that uses the PROCESSOR NORMAL/AGC-CLIPPER DEFEAT switch) begins on page 4-11.

System Measurement Through OPTIMOD-HF

1) Enter the SYSTEM BYPASS mode by operating the momentary front-panel SYSTEM NORMAL/BYPASS switch, or by activating the corresponding rear-panel remote control terminal (see page 2-12).

2) To test the transmitter, apply desired modulation levels and frequencies (from 50 to 4500Hz).

Frequency response will typically be better than ±0.5dB, 50–4500Hz.

Assuming that OPTIMOD-HF's output level was correctly matched to your transmitter prior to testing, you will ordinarily be able to get quite close to 100% modulation before OPTIMOD-HF's safety clipper starts to clip the test signal. Only if you had to reduce drive to the transmitter because of bounce or other problems that could not be corrected with OPTIMOD-HF's Transmitter Equalizer will modulation depth be significantly limited by OPTIMOD-HF's safety clipper in this BYPASS mode (see page 2-15).

Field Audit of Performance

This procedure is useful for detecting and diagnosing problems with the 9105A's performance. It includes checks of frequency response, program equalizer response, noise and distortion performance, and various parameters of normal operation (distortion and band-limiter operation).

By its nature, this performance audit is limited in scope to discovering *static* problems. A dynamic problem in the AGC circuitry (caused by the failure of a timing module on Card #6, for example) would generally not be detected by these tests. For this reason, instrument measurements must always be complemented by listening. If you are well-acquainted with the "sound" of the 9105A, faults that develop will ordinarily be quite easy to diagnose by ear.

If the 9105A fails to pass any of these tests, see Section 5 for troubleshooting information.

Equipment required:

Ultra-low distortion sine-wave oscillator/harmonic distortion meter/audio voltmeter

With verified residual distortion below 0.0015%. Sound Technology 1710B or equivalent preferred.

Spectrum analyzer with tracking generator

Tektronix 5L4N plug-in with 5111 bistable storage mainframe, or equivalent. *Alternatively*, a sweep generator with 50–15,000Hz logarithmic sweep can be used with an oscilloscope in X/Y mode.

It is often more convenient to make measurements on the bench away from high RF fields which could affect results. In a high RF field it is, for example, very difficult to accurately measure the very low harmonic distortion produced by a properly-operating 9105A at most frequencies. However, in an emergency situation (and is there any other kind?), it is usually possible to detect many of the more severe faults which could develop in the 9105A circuitry even in high-RF environments.

- See the assembly drawings in Section 6 for component locations.
- The levels given in these procedures are for test purposes only; guaranteed performance levels are stated in the specifications in Section 6.
- **Follow these instructions in order without skipping steps.**

IMPORTANT

Turn off AC power to the 9105A before removing or installing circuit cards.

1) Prepare the unit.

A❑ Record the current settings of the 9105A's controls, then set the controls as follows:

EQ	OUT
INPUT ATTEN	7
PROCESSOR	AGC/CLIPPER DEFEAT
HILBERT CLIPPER DRIVE #1	0
CLIPPING	-4
GATE THRESHOLD	HI
TX EQ	OUT
PROCESSOR PRESET	#1
PROCESSOR NORMAL/BYPASS	NORMAL

The settings of controls not listed can be left as they were.

2) Check frequency response.

This test measures the total system response, including the input and output 4.5Khz low-pass filters, the low-pass filters within the Hilbert-Transform clipper, the 50Hz high-pass filter, the supersonic low-pass filter, and all pre- and post-limiter crossover filters in the multi-band limiter.

A❑ Connect the output of a tracking or sweep generator to the INPUT terminals. Connect the input of the spectrum analyzer or oscilloscope to the 9105A's OUTPUT terminals.

B❑ Set the generator for a 20–7500Hz logarithmic sweep.

C❑ Set the VU meter selector to AGC.

D❑ Set the output level of the generator to produce a reading of -6VU on the VU meter. If this cannot be achieved, adjust the output level of the generator as necessary.

E❑ Set the VU meter selector to MULTI-BAND LIM.

F❑ Adjust the DENSITY #1 control to produce a reading of −6VU.

If a tracking or sweep generator and spectrum analyzer are not available, the frequency response can be measured with an audio oscillator and noise & distortion test set. If you will be doing this, ignore the rest of step 2, and instead: Set the VU meter selector to AGC. Connect the sine-wave oscillator to the 9105A's INPUT terminals. Set the oscillator to 50Hz, and adjust its output level to produce a VU meter reading of −6VU. Connect the noise & distortion test set to the 9105A's OUTPUT terminals. Measure the frequency response with the oscillator set to 1kHz, then verify that response at 50Hz, 100Hz, 400Hz, 1kHz, 2.5kHz, and 4kHz is within ±1dB of that measured at 1kHz.

G❑ Connect the input of a spectrum analyzer or oscilloscope between the OUTPUT + and OUTPUT − terminals.

If you can't get an on-screen display, adjust the OPTIMOD-HF OUTPUT ATTENUATOR to obtain one.

H☐ Verify that the swept output is flat ±1dB from 50–4500Hz.

3) Check program equalizer response.

A☐ Verify that the GREEN program equalization module is installed on Card #4.

If not, temporarily replace the installed module with the GREEN module supplied with the 9105A.

B☐ Set the BASS EQ control to 0, the HF EQ BOOST control to 22, and the RECEIVER EQUALIZER IN/OUT switch to IN.

C☐ Reduce the output level of the sweep generator or oscillator by 20dB.

This avoids system overload due to high-frequency boost.

D☐ Verify that the swept response of the system is similar to that shown in Fig. 4-1.

Once again, if a spectrum analyzer is not available, an audio oscillator and oscilloscope may be substituted — see note at step 2-F.

Note that the response at 3kHz and above will vary slightly from unit to unit, and you may have to adjust the HF EQ BOOST control slightly to duplicate the response shown in Fig. 4-1. After making this adjustment, you should be able to duplicate the ideal response ±1dB to 4.5kHz.

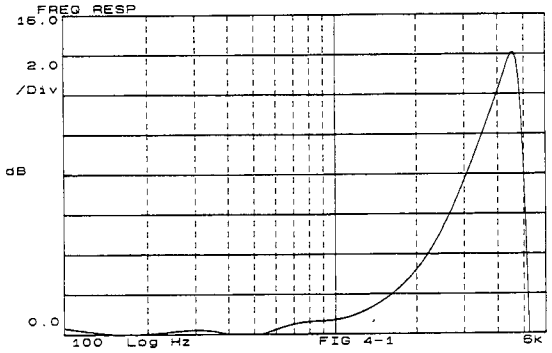


Fig. 4-1: High-frequency Program Equalizer Response at Maximum Equalization

E☐ Set the HF EQ BOOST control to "0" and the BASS EQ control to "6".

F☐ Verify that bass is boosted 6dB (±1dB), centered at approximately 100Hz (±10%).

G☐ If the pre-emphasis module on Card #4 was replaced with the GREEN module in step A, reinstall the replaced module now.

H☐ Set the RECEIVER EQUALIZER IN/OUT switch to OUT.

I☐ Disconnect the tracking or sweep generator and the spectrum analyzer or oscilloscope from the 9105A.

4) Check noise and distortion performance.

A☐ Connect a harmonic distortion meter to the OUTPUT + and OUTPUT − terminals. Set the harmonic distortion meter's bandwidth to 80kHz.

B☐ Set the VU meter selector to AGC.

C☐ Connect a sine-wave oscillator to the 9105A's INPUT terminals.

D☐ Set the oscillator to 50Hz

E☐ Adjust the oscillator's output level to produce a VU meter reading of -6VU.

F☐ Set the 9105A's VU meter selector to MULTI-BAND LIMITER.

G☐ Adjust the DENSITY #1 control to produce a reading of −6VU on the VU meter.

H☐ Verify that harmonic distortion does not exceed 0.1%.

In many cases, measured results will be constrained entirely by the quality of the oscillator and harmonic distortion meter, and/or by the presence of RF fields.

If an SMPTE intermodulation analyzer is available, verify that intermodulation distortion is less than 0.2%.

I☐ Repeat steps G and H with the oscillator set to 100Hz, 400Hz, 1kHz, 2kHz, 3kHz, and 4.5kHz.

IMPORTANT: Each time you reset the oscillator's frequency, adjust its output level to produce a reading of −6VU (±0.5VU) on the VU meter.

J☐ Set the oscillator's frequency to 1kHz, and adjust its output level to produce a reading of −6VU on the VU meter.

K☐ Set the harmonic distortion meter's 0dB reference at a point 11dB above the level produced by the oscillator as currently set up.

The level produced by the tone is 11dB below the 100% modulation level.

L☐ Disconnect the audio oscillator from the INPUT terminals.

M☐ Verify that the noise at the OUTPUT terminals is at least 70dB (and preferably 75dB) below the 0dB reference level set above.

Note that hum or buzz due to test equipment grounding problems and/or high-RF fields may result in falsely high readings. Such problems should become immediately apparent if the output of the harmonic distortion meter is monitored with an oscilloscope.

If you observe substantial hum in the output, disconnect all leads from the INPUT terminals, and short the INPUT + and INPUT – terminals together. If there is still hum, carefully check the grounding of the instruments (make sure that no ground loops have been introduced through the AC power line).

5) Check NORMAL mode distortion.

A☐ Move jumper A on Card #6 to the AGC DEFEATED position.

See Fig. 2-3 on page 2-9. Because the bass roll-off in the control loop of the broad-band automatic gain control (AGC) can cause certain stages to be overdriven while making sine wave measurements at low frequencies, the AGC circuit must be defeated before making the following measurements.

B☐ Set the PROCESSOR switch to NORMAL.

C☐ Set the 9105A's VU meter selector to AGC

D☐ Set the oscillator's frequency to 1.6kHz, and adjust its output level to produce a reading of –6VU on the VU meter.

E☐ Verify that the BROADBAND AGC G/R meter reads 0dB, and that the GATE lamp is lit.

This indicates that broad-band AGC has indeed been defeated and that OPTIMOD-HF is operating with normal gain.

F☐ Set the DENSITY #1 control so the 1.6kHz MULTI-BAND LIMITER G/R meter reads –5dB.

G☐ Verify that the harmonic distortion at the OUTPUT + terminal is 0.25% or less when the oscillator is set to 100Hz, 400Hz, 2kHz, 3kHz, and 4.5kHz.

These distortion readings may vary quite widely, but should not exceed 0.25%. Frequencies close to 1kHz will exhibit much higher distortion because the multi-band clipper is driven very hard in this frequency range.

H☐ Set the oscillator frequency to 1.6kHz.

I☐ Advance the CLIPPING control and verify that the harmonic distortion increases suddenly.

This should occur when CLIPPING control is set near -3; it indicates that the multi-band clipper has started to clip.

J☐ Set the CLIPPING control to +2.

K☐ Verify that the harmonic distortion at the OUTPUT + terminal is approximately 5%, +3%, –2%.

The observed distortion should consist almost entirely of odd harmonics (mainly third-order).

6) Check Hilbert-Transform clipper operation.

A❑ Reduce the setting of the CLIPPING control until there is once again no noticeable clipping in the multi-band clipper.

The harmonic distortion should be less than 0.25%.

B❑ Switch the VU meter to H-T CLIPPER.

C❑ Advance the DENSITY #1 control to +3.

D❑ Advance the HILBERT CLIPPER DRIVE #1 control to +6.

As you do so, note that beyond a certain setting, the VU meter indication no longer increases, but instead stays steady. This indicates that the Hilbert-Transform clipper is actively reducing gain.

Verify that the harmonic distortion does not exceed 2.5%.

If it does, there is probably a fault in the 90° phase difference networks or in the vector sum generator circuitry on Card #5 (Hilbert-Transform clipper).

E❑ Reset the HILBERT CLIPPER DRIVE #1 control to "0".

F❑ Move jumper A on Card #6 to the AGC ENABLED position.

See Fig. 2-3 on page 2-9.

G❑ Disconnect the audio oscillator and harmonic distortion meter from the 9105A.

7) Check NORMAL mode band-limiter operation.

A❑ Connect a pink noise generator to the INPUT terminals. Adjust the pink noise generator's output to produce a BROADBAND AGC G/R meter reading of 0dB.

B❑ Adjust the DENSITY #1 control until the 700Hz MULTI-BAND LIMITER G/R meter reads 10dB.

C❑ Verify that the other MULTI-BAND LIMITER G/R meters read as follows (±3dB):

150Hz	16dB
420Hz	13dB
1.6kHz	8dB
3.7kHz	8dB

This applies to the standard 9105A only. Card #6 is supplied on special order in two special variants: "variant A" and "variant B". By comparison with the standard 9105A, these variants have different thresholds of limiting in certain frequency bands. The variant number is marked on Card #6.

If you have "variant A", the 150Hz band should read 10dB G/R and the 1.6kHz band should read 12dB G/R. (All other bands should read as in the table above.)

If you have "variant B", the 150Hz band should read 10dB G/R. (All other bands should read as in the table above.)

A reading outside of tolerance can indicate a problem with the band-limiter's control circuitry. Because of the non-periodic nature of pink noise, certain failures in the control circuitry dynamic response may also be indicated in these tests. Such failures ordinarily require return of Card #6 to the factory for diagnosis and repair.

8) Return OPTIMOD-HF to service.

A☐ Replace the subpanel and close the front panel.

See page 4-5 for instructions.

B☐ Reset the controls to the settings recorded in step 1.

Field Alignment

These field alignment instructions are included primarily for reference — *routine alignment is neither necessary nor desirable* due to the high stability of the circuitry.

WARNING

If calibration is necessary, we *strongly recommend* that the circuit card in question be returned to the factory for calibration by our experienced technicians. They have access to special test fixtures and exact-replacement spare parts. Only in an emergency should you attempt to align and calibrate the 9105A in the field.

This procedure is organized by circuit card, from the 9105A's input to its output, in signal path order. Because the calibration of each card depends upon accurate calibration of the cards before it, the cards must be calibrated in the order specified in these instructions. Since you do not have our special test fixtures, you must use the 9105A itself as a test fixture, and the entire unit must be aligned as a system.

Note that no calibration is necessary for Cards #4, #6, #7, and #8. Tolerance build-up in those cards is compensated for in the adjustment of alignment controls on other cards. In particular, the quiescent gains of the band VCAs on Cards #2 and #3 are aligned to compensate for cumulative tolerances in the filters and crossovers throughout the rest of the system.

While specifications will usually be met after a faulty card is replaced with a factory-aligned card, best results are obtained by a touch-up alignment after such replacement. This is particularly true if Cards #2 or #3 are replaced.

Equipment required:

Ultra-low distortion sine-wave oscillator/THD analyzer/audio voltmeter

With verified residual distortion below 0.0015%. Sound Technology 1710B or equivalent preferred.

Spectrum analyzer with tracking generator

Tektronix 5L4N plug-in with 5111 bistable storage mainframe, or equivalent. *Alternatively*, a sweep generator with 50–5000Hz logarithmic sweep can be used with an oscilloscope in X/Y mode for all cards except Cards #8 and #9 — a spectrum analyzer *must* be used to verify the calibration of Cards #8 and #9.

Digital voltmeter

Accurate to ±0.1%

Audio voltmeter

Accurate to ±2%. For example, Sound Technology 1700 A/B or 1710.

Oscilloscope

DC-coupled, triggered-sweep, with 5MHz or greater vertical bandwidth.

One 10.0K 1% 1/8-watt metalfilm resistor

The wattage is not critical.

One short test lead

With miniature alligator clips or E-Z Hooks on both ends.

Pink noise generator

Such as this one from the *National Semiconductor Audio/Radio Handbook*:

It is assumed that the technician is thoroughly familiar with the operation of this equipment.

- See the assembly drawings in Section 6 for component locations.
- The levels given in these procedures are for test purposes only; guaranteed performance levels are stated in the specifications in Section 6.
- **Follow these instructions in order without skipping steps.**

IMPORTANT

Turn off AC power to the 9105A before removing or installing circuit cards.

1) Prepare the unit.

A☐ Remove the 9105A from its rack and place it on a test bench *away from RF fields.*

B☐ Record the settings of all 9105A controls.

C☐ Connect the 9105A's ⏚ and ⏚ terminals together.

D☐ Open up the 9105A's front panel and remove its subpanel.

See page 4-5 for instructions.

E☐ Set the 9105A's AC POWER switch to OFF.

F☐ Remove Card #2 from its slot, insert an extender card into slot #2, then insert Card #2 into the extender card.

G☐ Set the AC POWER switch to ON.

Each time you turn on the 9105A, allow it to stabilize for 2 minutes.

2) Calibrate 15-volt power supply on Card #PS.

A☐ Observe the voltage at pin B of Card #2 (currently extended) with a digital voltmeter. If it reads +15.00VDC ±0.05V, skip to step E.

B☐ Open the top cover by removing the thirty screws that hold it in place.

C☐ Adjust +15 ADJ trimmer R106 on Card #PS until the digital voltmeter indicates +15.00 volts.

D☐ Replace the top cover.

E☐ Verify that the voltage at pin E of Card #2 is between −14.85 and −15.15 volts.

If it is not, see the troubleshooting information in step 2 on page 5-4.

3) Null VCA distortion. (Card #2)

A☐ Set the PROCESSOR switch to AGC/CLIPPER DEFEAT.

B☐ Connect one side of a 10.0K ±1% resistor to the output of an audio oscillator. Connect the other side of the resistor to a short jumper lead ending in a miniature alligator or E-Z Hook test clip.

The wattage of the resistor is not critical. If a 1% resistor is not available, use a 10.0K 5% ¼-watt carbon film resistor (although this will slightly compromise the accuracy of the VCA gain trim adjustments that follow).

C☐ Set the oscillator to 1kHz, and adjust its output level to −10dBu.

0dBu=0.775V rms. Read dBu on the "dBm/600Ω" scale of your voltmeter.

D❑ Connect the oscillator's output to the – input of the BROADBAND VCA.

See the following table. Connect the oscillator test lead to the "Input Opamp" side of "Input Resistor". For the BROADBAND VCA, this is the IC11 side of R1 (alternatively, you could attach the lead directly to pin 2 of IC11).

VCA	Input Resistor	Input Opamp	Output Opamp	Card #2 Edge Pin	DIST NULL Trimmer	THUMP NULL Trimmer
BROADBAND	R1	IC11, pin 2	IC10, pin 7	19	R7	R4
150Hz	R37	IC1, pin 6	IC1, pin 1	F	R42	R39
700Hz	R19	IC4, pin 6	IC4, pin 1	J	R24	R21
3.7kHz	R55	IC6, pin 6	IC6, pin 1	L	R60	R57

E❑ Connect the input of a harmonic distortion meter to the output of the BROADBAND VCA.

See the table at step D. Connect the harmonic distortion meter to the "Output Opamp" or to the corresponding Card #2 edge connector pin. For the BROADBAND VCA, this is pin 7 of IC10 or pin 19 of the Card #2 edge connector.

The level at the BROADBAND VCA output point should be approximately 0dBu.

F❑ Adjust the BROADBAND VCA DIST NULL trimmer to minimize the distortion observed at the VCA's output.

See the table at step D. The DIST NULL trimmer for the BROADBAND VCA is R7.

G❑ Repeat steps D through F for each of the other VCAs on Card #2: the 150Hz, 700Hz, and 3.7kHz BAND VCAs.

The level at each band-limiter output point should be approximately +10dBu.

See the table at step D for appropriate test points and trimmers.

H❑ Disconnect the oscillator and harmonic distortion meter from Card #2.

I❑ Remove Card #2 from the card extender and return it to slot #2.

4) Null VCA distortion. (Card #3)

A❑ Extend Card #3.

B❑ Null the distortion of the 400Hz, 1.6kHz, and 6.2kHz BAND VCAs on Card #3.

The level at the output of the 6.2kHz band will be approximately +16dBu.

Connect the test instruments as you did for Card #2 in steps 3-D through F, *but use the following test point and trimmer information*:

VCA	Input Resistor	Input Opamp	Output Opamp	Card #3 Edge Pin	DIST NULL Trimmer	THUMP NULL Trimmer
400Hz	R37	IC1, pin 6	IC1, pin 1	F	R42	R39
1.6kHz	R19	IC4, pin 6	IC4, pin 1	J	R24	R21
6.2kHz	R55	IC6, pin 6	IC6, pin 1	L	R60	R57

IMPORTANT

If any DIST NULL trimmer is adjusted, the corresponding THUMP NULL trimmer must adjusted to re-null VCA thump.

5) Null VCA thump. (Card #3)

A☐ Set the oscillator to 1kHz, and adjust its output level to −30dBu.

B☐ Through the same resistor and lead as before (see step 3) on page 4-20), connect the oscillator's output to junction of R75 and CR5.

This will modulate the bias current for all VCAs on Card #3 at a 1kHz rate.

C☐ Connect the input of an AC voltmeter to the output of the 400Hz VCA.

See the table at step 4-B.

D☐ Adjust the 400Hz VCA THUMP NULL trimmer to minimize the 1kHz signal observed at the VCA's output.

See the table at step 4-B. The THUMP NULL trimmer for the 400Hz VCA is R39.

E☐ Repeat steps C through D for the two other VCAs on Card #3: 1.6kHz and 6.2kHz

See the table at step 4-B for appropriate test points and trimmers.

6) Null VCA thump. (Card #2)

A☐ Disconnect the oscillator and harmonic distortion meter from Card #3.

B☐ Remove Card #3 from the card extender and return it to slot #3.

C☐ Extend Card #2.

D☐ Minimize the 1kHz signal observed at the output of the BROADBAND VCA, 150Hz VCA, 700Hz VCA, and 3.7kHz VCA.

Connect the test instruments as you did for Card #3 in step 5, *but use the test point and trimmer information found at step 3-D.*

7) Calibrate BROADBAND VCA gain. (Card #2)

A☐ Set the oscillator to 1kHz, and adjust its output level to exactly −10dBu.

B☐ Through the same resistor and lead as before, connect the oscillator's output to pin 2 of IC11 (or to the IC11 side of R1) on Card #2.

This is the input of the BROADBAND VCA. See the test point and trimmer information at step 3-D.

C☐ Connect the input of a harmonic distortion meter to the output of the BROADBAND VCA at pin 7 of IC10 (or at pin 19 on Card #2's edge connector).

D☐ Adjust GAIN trimmer R13 to produce a +1.6dBu (0.913V rms) level at the BROADBAND VCA's output.

8) Calibrate narrow band VCA gains. (Card #2)

A☐ Verify that the oscillator is set to 1kHz, and that its output level is exactly −10dBu.

B☐ Disconnect the oscillator from the BROADBAND VCA input, and connect it to the 150Hz BAND VCA input: pin 6 of IC1 (or to the IC1 side of R37).

Continue to use the same resistor in the test lead.

C☐ Disconnect the harmonic distortion meter from the BROADBAND VCA output, and connect it to the 150Hz BAND VCA output: pin 1 of IC1 (or to pin F on Card #2's edge connector).

D☐ Adjust BAND 1 GAIN trimmer R53 to produce a +10.6dBu (2.62V rms) level at the 150Hz BAND VCA output.

Do not adjust R53 in the following steps! The setting of this trimmer supplies a reference level.

E☐ Disconnect the oscillator and harmonic distortion meter from Card #2.

F☐ Remove Card #2 from the card extender and return it to slot #2.

After re-powering, wait until the BROADBAND AGC G/R meter settles to 0dB.

G☐ Verify that the RECEIVER EQUALIZER IN/OUT and the TX EQ IN/OUT switches are both set to OUT.

H☐ Set the VU meter selector to AGC.

I☐ Connect a tracking or sweep generator to the INPUT terminals. Set the generator for a 20–20,000Hz (or 50–5000Hz, if available on the instrument) logarithmic sweep, and adjust its output level to produce a VU meter reading of −6VU.

J☐ Set the VU meter selector to MULTI-BAND LIM.

K☐ Adjust the DENSITY #1 control to produce a VU meter reading of −6VU.

This ensures that no clipping will occur.

L❑ Connect the vertical input of the spectrum analyzer or oscilloscope to the OUTPUT terminals. Connect the horizontal input of the spectrum analyzer or oscilloscope to the sweep ramp of the tracking or sweep generator. Set the display for 2dB/division.

You are now observing the overall swept response of OPTIMOD-HF.

M❑ Adjust the GAIN trimmers controls for limiter bands 2 through 6 to achieve maximally-flat response.

These trimmers are located at the front of Cards #2 and #3, and can be adjusted without extending the cards.

Band:	Frequency:	GAIN Trimmer:	On Card:	
1	150Hz	R53	#2	**Do not re-adjust!**
2	400Hz	R53	#3	
3	700Hz	R35	#2	
4	1.6kHz	R35	#3	
5	3.7kHz	R71	#2	
6	6.2kHz	R71	#3	

You should be able to calibrate for a response better than ±1dB, 50–4500Hz.

9) Verify distortion cancellation. (optional)

A❑ Extend Card #7.

B❑ Disconnect the vertical input of the spectrum analyzer or oscilloscope from the OUTPUT terminals, and connect it to pin 7 of IC11 on Card #7 (the output of the supersonic low-pass filter).

Leave the horizontal input of the spectrum analyzer or oscilloscope connected to the sweep ramp of the tracking or sweep generator.

C❑ Verify that the sweep is flat ±1dB. Note the level of the trace.

D❑ Disconnect the vertical input of the spectrum analyzer or oscilloscope from the pin 7 of IC11, and connect it to pin 1 of IC8 (the distortion-canceling summing amp).

E❑ Verify that the swept response is at least 38dB below the level observed at pin 7 of IC11 in step C, in the range 50–4500Hz.

This tests the matching of the inverting and non-inverting filters in the multi-band clipper. Incorrect matching can cause overall frequency response errors because program material other than distortion can be introduced into the distortion-canceling sidechain. A major cancellation failure will result in non-flat response at pin 7 of IC11 because the output of the distortion-canceling sidechain was summed with the main signal before that point. (See the circuit description in Section 6 for a complete discussion.)

Fig. 4-2 shows both of the traces at once: the upper trace is the output of IC11 and the lower trace is the output of IC8. Note that the lower trace (showing the cancellation between the inverting and non-inverting filters) may take any shape. But it must always be at least 38dB below the upper trace.

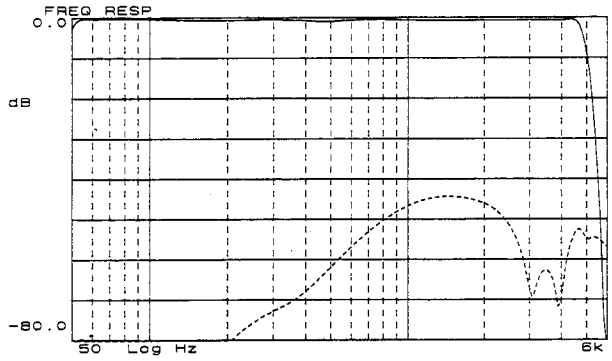


Fig. 4-2: Main and Distortion-canceling Sidechain Swept Response (PROOF Mode)

F☐ Disconnect the tracking or sweep generator from the INPUT terminals, and connect it to the junction of CR5 and CR6 on Card #7.

G☐ Set the tracking generator to produce a 20-20kHz sweep, and its output to produce approximately −10dBu.

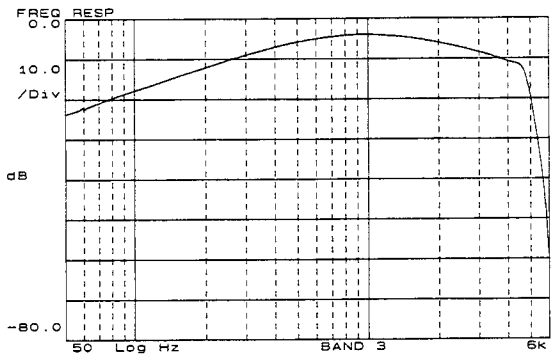
H☐ Disconnect the vertical input of the spectrum analyzer or oscilloscope from pin 7 of IC11 on Card #7 and connect it to pin 7 of IC7b on Card #7 (or to pin 21 of Card #7's edge connector).

Leave the horizontal input of the spectrum analyzer or oscilloscope connected to the sweep ramp of the tracking or sweep generator. The trace should resemble that shown for band 5 in Fig. 4-3

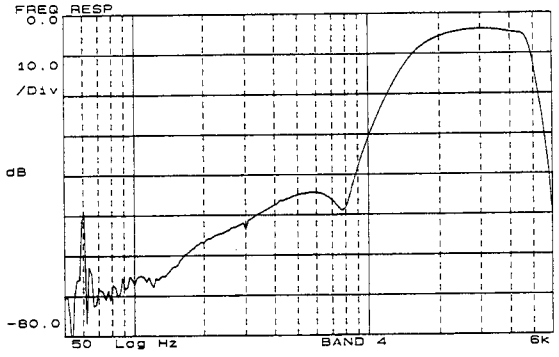
I☐ Verify that traces produced by the distortion-cancellation circuits of bands 3, 4, and 6 resemble those shown in Fig. 4-3. (optional)

Observe band 3 by driving the junction of CR1 and CR2 with the tracking generator, band 4 by driving the junction of CR3 and CR4, and band 6 by driving the junction of CR7 and CR8.

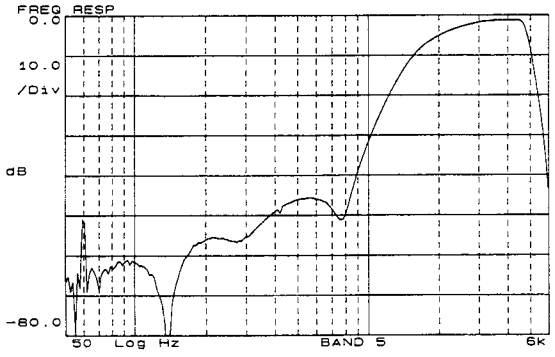
J☐ Remove Card #7 from the card extender and return it to slot #7.



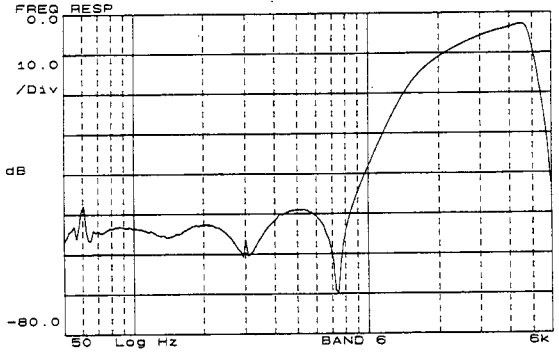
Band 3



Band 4



Band 5



Band 6

Fig. 4-3: Distortion Cancellation
(20–20,000Hz log sweep, 10dB/vertical division)

10) Calibrate Hilbert-Transform clipper.

A☐ Set the PROCESSOR NORMAL/AGC-CLIPPER DEFEAT switch to NORMAL.

B☐ Remove Card #7 from its slot.

C☐ Extend Card #5.

D☐ Connect the low-distortion oscillator to pin M of Card #5. Set its frequency to 3.5kHz and its output level to 0dBu.

E☐ Connect the harmonic distortion meter to TP2. Set the HILBERT CLIPPER DRIVE #1 control to produce 0dBu at TP2.

F☐ Set the oscillator to 50Hz. Adjust R93 (LF VCA GAIN) to produce 0dBu at TP2.

G☐ Adjust R88 (LF VCA DISTORTION NULL) for minimum harmonic distortion at TP2.

H❑ Move the harmonic distortion meter to pin 1 of IC18.

This is the output of the high-frequency VCA.

I❑ Set the oscillator frequency to 2kHz.

J❑ Adjust R99 (HF VCA DISTORTION NULL) for minimum harmonic distortion at pin 1 of IC18.

K❑ Turn the HILBERT CLIPPER DRIVE #1 control fully clockwise.

L❑ Advance the output level of the oscillator until the level at pin 1 of IC18 stops increasing. Then vary the oscillator level between this level and a level 6dB higher, adjusting R70 (RATIO) until the level at pin 1 of IC18 does not change at all as the oscillator level is varied.

As you vary the setting of R70, you will observe that the level at pin 1 of IC18 either *increases* or *decreases* as the oscillator level is varied. There is only one setting of R70 where the level at pin 1 stays constant.

M❑ Set the oscillator level 6dB beyond where the level at pin 1 no longer changes. Adjust R55 (RIPPLE NULL) to minimize the harmonic distortion.

The harmonic distortion should be less than 1%. The level of distortion obtainable depends on the accuracy of the 90° phase difference produced by the Hilbert transformer at the frequency being measured, and upon the accuracy of the vector sum circuitry associated with IC6.

N❑ Move the harmonic distortion meter to TP2. Adjust R106 (GAIN TRIM) to produce +13.0dBu (3.50V rms) at TP2.

O❑ Connect the oscillator to pin 3 of IC12 through the same 10.0K resistor/E-Z Hook test clip combination that you used in step 3-D on page 4-21.

P❑ Observe TP2 with an oscilloscope.

Q❑ Set the oscillator to 100Hz, and adjust its output until a distorted feedthrough component can be easily seen on the oscilloscope. Adjust R86 (LF VCA THUMP NULL) and R98 (HF VCA THUMP NULL) to null the feedthrough component.

It is easy, by iterating between R86 and R98, to null both VCAs by observing their sum at TP2. If, for some reason, you have difficulty doing this, you can instead null each VCA individually by observing its output. The output of the LF VCA is pin 7 of IC9; the output of the HF VCA is pin 1 of IC18.

R❑ Disconnect the oscillator.

S❑ Set the NORMAL/SQUAREWAVE switch to SQUAREWAVE. Adjust R139 (SQUAREWAVE INJECTION LEVEL) to produce 3.5V peak-to-peak at TP2.

This corresponds to 30% modulation. If you prefer to perform your TX EQ setup at a different squarewave modulation level, readjust R139 accordingly.

T❑ Disconnect all test equipment from Card #5 and return it to its slot.

U❑ Plug Card #7 back into its slot.

11) Return OPTIMOD-HF to service.

A☐ Disconnect all test instruments from the 9105A.

B☐ Remove the jumper connecting the 9105A's ⏚ and ⏚ terminals — unless it is normally present in your installation.

C☐ Set the AC POWER switch to ON.

D☐ Replace the subpanel and close front panel.

See page 4-5 for instructions.

E☐ Return controls to the settings recorded in step 1.

F☐ Return the 9105A to its rack and reconnect it.

Section 5 Troubleshooting

page contents

5-2 Troubleshooting the 9105A

5-12 Components: Fault Diagnosis, Replacement

5-14 Technical Support
Factory Service, Shipping Instructions

CAUTION

The installation and servicing instructions in this manual are for use by qualified personnel only. To avoid electric shock do not perform any servicing other than that contained in the Operating Instructions unless you are qualified to do so. Refer all servicing to qualified service personnel.

Troubleshooting the 9105A

Many problems experienced in the field can be resolved or conclusively diagnosed with the following procedures. Even if the repair cannot be done in the field, the information provided by these diagnostic routines will facilitate speedy assistance by Customer Service and, if necessary, repairs by the factory.

Please follow these troubleshooting instructions and make notes if you observe anything exceptional or unusual.

- See "Getting Inside the Chassis" on page 4-4 for instructions on opening up the unit, removing the subpanel, and getting to the less accessible parts of the interior. See the assembly drawings in Section 6 for locations of components and test points.
- Before troubleshooting at the component level or replacing components, see "Components: Fault Diagnosis, Replacement" on page 5-12.

IMPORTANT

Always turn off AC power to the 9105A before removing or installing circuit cards. Allow the 9105A to stabilize for two minutes after turning the power back on.

The following instructs you to first determine that the problem is with the 9105A and not with some other piece of equipment. The troubleshooting procedure then progresses through checking the power supply, isolating the faulty circuit with the VU meter, and checking individual circuit cards.

After performing step 1, proceed to the indicated step if you observe any of the following symptoms.

If the problem is:	See step:	On page:
Faulty BROADBAND AGC G/R meter	4	5-5
Faulty TX EQ switching	6	5-7
Whistle on air	7	5-7
Buzz or hum	8	5-7
Loss of modulation control	9	5-7
Output frequency balance	11	5-8
Voice too loud	12	5-8
High-frequency response	13	5-9
Subtle to moderate distortion	14	5-9
Severe distortion	15	5-10
Sibilance	16	5-10
Low modulation levels in sinewave testing	17	5-10
Abnormal GATE light behavior	18	5-11
Pumping	19	5-11
Lost keys	Security	1-12

1) Determine that the problem is caused by the 9105A, and not by other equipment.

A☐ Check the controls and connections.

Could the problem have been caused by someone changing the control settings? Are the controls in their normal operating positions? Have phone lines, patch bays, or other audio components of your chain, STL, or transmitter/antenna system been recently maintained or modified?

B☐ Check the audio signal going into the 9105A.

If a standby audio processor is available, substitute it for the 9105A to see if the problem vanishes. If a standby unit is not available, check the audio quality at the 9105A's INPUT terminals with a high-quality monitor system.

Even slight distortion can be greatly exaggerated by processing. So, although relatively minor problems which develop in the station's audio chain or STL can be magnified by 9105A, such distortion does not necessarily indicate that the 9105A is in any way defective. *Always be sure that the problem is not in the source material being fed to the 9105A.*

C☐ Check the audio signal coming out of the 9105A.

If the audio is clean going into the 9105A, check the equipment downstream from the 9105A, including any distribution amplifiers and switching. If a standby transmitter is available, substitute it to see if the problem vanishes. If no standby equipment is available, connect the audio output of the 9105A through the Monitor Roll-Off Filter into a high-quality amplifier and loudspeaker to see if the problem can still be heard. If the problem vanishes when you observe the output of the 9105A directly, then downstream equipment is strongly suspect. If the problem does not go away, verify that the problem is not in the monitoring amplifier or loudspeaker by listening to the 9105A's output on another monitor.

In countries where government broadcasting authorities own the transmitters, the 9105A operator may not have access to the transmitter hardware. In our experience, particularly difficult problems can be introduced by these transmitters and their protection limiters. Beyond carefully adjusting 9105A output levels so that the transmitter's protection limiter is rarely (or never) activated, there may be nothing the 9105A operator can do to correct such system problems. These problems can occur even when steady-state (sine-wave) measurements indicate that the system is meeting specifications, because steady-state measurements do not assess dynamic effects — particularly those in the transmitter's protection limiter.

D☐ Check grounding.

Changes in or deterioration of grounding and/or exterior lead dress can sometimes cause RFI or hum problems to appear in a correctly-operating 9105A.

If the fault has been positively isolated to the 9105A, continue with this fault localization routine.

The following troubleshooting procedures employ the technique of *signal tracing*: the signal is observed at various points as it passes from the input to the output. If the signal is normal at one point in the circuit, but is abnormal at another point nearer the output, the problem lies in circuitry between the two points.

2) Check the power supply.

A☐ *If you are getting hum or buzz,* set the 9105A's VU meter selector to +15 VDC, and verify that the VU meter reads 0VU ±0.5VU.

B☐ Set the 9105A's VU meter selector to −15 VDC, and verify that the VU meter reads 0VU ±0.5VU.

If both readings are as expected, skip to step 3.

If either reading is significantly low, it could indicate a defect in the supply itself, but it is more likely that a shorted IC or capacitor somewhere in the circuit is overloading the supply and causing it to current-limit. (The power supply is electronically protected against excessive current demand by other parts of the circuitry. If a failure causes a high current demand on the power supply, its output voltage will drop as far as necessary to reduce output current to approximately 0.75A.)

C☐ *If the VU meter readings are abnormally low,* unplug each circuit card in turn and check if the VU meter recovers to 0VU.

Leave the VU meter selector set to −15 VDC. Since the negative regulator tracks the +15V supply, the −15V supply will go down if the +15V supply does, even if the −15V supply or load is completely normal. A normal −15 VDC reading thus assures a normal +15 VDC reading.

If recovery occurs, troubleshoot the unplugged circuit card (see page 5-12). Ordinarily, the defective component will become *very hot,* and so be easily detected by touch. But be careful: wet your finger first to avoid burns!

If the VU meter reading does not recover, examine the meter card, motherboard, and chassis wiring before suspecting the power supply itself. Very low resistance between circuit ground and the +15V supply or between circuit ground and the −15V supply indicates a wiring problem. (Be sure to measure with AC power off.)

D☐ If the unit passes the above tests, use a well-calibrated DVM, oscilloscope, and audio voltmeter (with 20–20,000Hz bandpass filter) to verify that the +15-volt supply is +15.00V ±0.075V, that the −15-volt supply is −15.00V ±0.15V, that ripple is less than 2mV rms peak from 20–20,000Hz, and that there is no high-frequency oscillation.

The 15-volt supplies can be most easily measured by extending a circuit card. +15V is available at pin B of the card connector, −15V is available at pin E, and circuit ground is available at pin C.

If power supply passes these tests, continue with step 3.

3) Isolate the faulty circuit with the 9105A's VU meter.

A☐ Feed typical audio to the 9105A.

B☐ Set the 9105A's VU meter selector to each position and verify that the reading is normal for that position.

Check readings in the order given below. If a reading is abnormal, check the circuit card indicated in this chart. Compare the various VU meter readings with the readings you have typically observed in normal operating conditions.

The block diagram (page 6-47) and schematics (page 6-46) in Section 6 indicate exactly where in the circuitry each VU meter reading is taken. (Note that problems other than gross gain changes or total failure to pass signal may not be detected by the meter alone.)

It is normal for the INPUT FILTER and RECEIVER EQ positions to read *very low* with program material because, to achieve adequate headroom, internal signal levels are very low at these meter points. If the meter can be seen to be moving at all, assume that there is normal signal present at these points.

If normal at:	But abnormal at:	Check:
INPUT terminals (checked in step 1)	AGC	Input amp, filters on Card #4 or broad-band VCA on Card #2
AGC	RECEIVER EQ	Receiver EQ on Card #4
RECEIVER EQ	MULTI-BAND LIM	Pre-compressor crossovers on Card #4, multi-band VCAs on Cards #2 and #3, or Card #7
MULTI-BAND LIM	H-T CLIPPER	Hilbert-Transform Clipper on Card #5, Safety clipper, supersonic filter on Card #7
H-T CLIPPER	TX OUTPUT	Safety clipper, supersonic filter, TX EQ on Card #8

4) If any G/R meters read abnormally:

Problems with Card #2 or #3 are often indicated by abnormal behavior of the gain reduction meters. If the BROADBAND AGC G/R meter or one of the MULTI-BAND LIMITER G/R meters seems to get stuck at "0" or at the bottom of its red zone, there is probably something wrong with the VCAs on Cards #2 and #3, or with the VCA control circuitry on Card #6. If the BROADBAND AGC G/R meter does not read "0" with no signal, check the broad-band VCA control circuitry on Card #6. Also suspect this circuitry if the BROADBAND AGC G/R meter does not read "0" when the PROCESSOR switch is set to AGC/CLIPPER DEFEAT.

A❑ If the broad-band AGC will not operate at all, verify that jumper A on Card #6 is in the AGC ENABLED position.

See Fig. 2-3 on page 2-9.

B❑ If any of the multi-band G/R meters read in the red at all times, swap Cards #2 and #3.

If the problem moves from band 1 (150Hz), 3 (700Hz), or 5 (3.7kHz) to band 2 (420Hz) or 4 (1.6kHz), the problem is on Card #2. If the problem moves from band 2 or 4 to band 1, 3, or 5, the problem is on Card #3. If the problem stays in the same band, the problem is probably in the VCA control circuitry on Card #6.

When Cards #2 and #3 are swapped, the 9105A will no longer pass signal because the Broad-band AGC VCA has been moved out of the signal path. This swap technique is thus only useful in diagnosing problems

where the VCAs might be very noisy or oscillating, thus activating the compressor control circuitry on the noise or oscillation.

C❑ Return Cards #2 and #3 to their normal slots.

5) Check Cards #4, #5, #7, #8.

A❑ Set the EQ IN/OUT switch to OUT.

If the problem vanishes, the problem is probably on Card #4.

B❑ Set the EQ IN/OUT switch to IN.

C❑ Set the TX EQ IN/OUT switch to OUT.

If the problem vanishes, the problem is probably on Card #8.

D❑ Return the TX EQ switch to IN.

E❑ Set the PROCESSOR switch to BYPASS.

If the problem vanishes, it is probably in the last part of Card #4, the first part of Card #7, or the first part of Card #5.

See the block diagram on page 6-47 to determine which parts of the circuitry are bypassed by this switch. These bypassed parts are suspect if the problem vanishes in BYPASS. You will have to extend the cards one at a time in order of signal flow — first #4, then #7, then #5 — and trace the signal through the circuitry to narrow the fault down to a single card.

If the problem does *not* vanish, it is in the very first part of Card #4, the last part of Card #5, the last part of Card #7, or Card #8 (see block diagram).

F❑ Set the PROCESSOR switch to NORMAL.

G❑ Connect a DC-coupled oscilloscope to the L TX OUT terminals.

H❑ Verify that the output waveform is quite clipped, and that both positive and negative peak levels are very consistent and tightly controlled.

Failure to control modulation tightly is probably due to a faulty Hilbert-Transform clipper on Card #5, or a faulty safety clipper on Card #7. Troubleshooting the peak-control circuitry on Card #5 is tricky and is best left to the factory (see the detailed circuit description of the Hilbert-Transform clipper on page 6-21 if you want to try it yourself). The safety clipper on Card #7 is very simple; check the clipper diodes and the ±4.1V clipper bias supplies (IC9), all on Card #7.

If modulation is well controlled at the 9105A's output, but your modulation monitor indicates inconsistent peaks, suspect problems with the transmitter or monitor (see page 1-4).

I❑ Set the TX EQ IN/OUT switch to IN.

6) If the TX EQ PRESET switching is not working properly:

A☐ Check the logic on Card #8.

There is also a small amount of logic associated with this function on the meter resistor card behind the front panel.

B☐ Check for interconnect, meter resistor card, or RFI filter box defects.

7) If you hear on-air whistle:

A☐ Check the power supply.

See step 2. A whistle is usually due to power supply oscillation, which can be caused by dried-out electrolytic capacitors C111 or C112, or by regulator chips IC101 or IC102 on Card #PS. A whistle could also be caused by oscillation elsewhere in OPTIMOD-HF's circuitry.

8) If you hear buzz or hum:

A☐ Check the power supply.

See step 2. Low line voltage an cause the regulator to drop out and pass ripple. Failure of capacitors C101 or C102 in the unregulated power supply could result in extremely high ripple (the power supply regulator will drop out on each ripple cycle which dips below 17.5 volts).

B☐ Check for improper grounding.

Verify that the 9105A is properly grounded to its rack.

In a high-RFI environment, you may need to improve the grounding scheme, relocate the 9105A, or, in the most extreme cases, change the length of input or output cables to re-tune them.

C☐ Make sure that the *input* to OPTIMOD-HF is clean and free from buzz or hum. OPTIMOD-HF can exaggerate these source problems, if present.

9) If modulation control is lost:

A☐ Verify that the MODE switch is set to OPERATE.

B☐ Temporarily turn the TX EQ switch OFF (if currently ON), and verify that peaks levels at the TX OUT terminals are tightly controlled.

If the TX EQ switch is ON, the transmitter equalizer will predistort the waveform to compensate for waveform fidelity errors in your transmitter. This predistorted waveform may appear to have poorly-controlled peaks. However, the peaks will be correctly controlled after they pass through the transmitter.

C☐ If peaks levels at the TX OUT terminals are *not* tightly controlled, check the ±4.1V power supply (IC9) on Card #7.

D☐ If peaks levels at the TX OUT terminals *are* tightly controlled, check the connection to the transmitter (including the STL, if used).

Inadequate phase linearity and/or frequency response in the circuit path *after* OPTIMOD-HF can change peak levels, which can result in overshoots and loss of modulation control. (This problem should appear immediately upon installation.) Sometimes such problems can be adequately corrected with the transmitter equalizer, but it is far better to have an accurate link that does not require equalization.

10) If occupied bandwidth is excessive:

A☐ Check modulation level. Carrier pinch-off can cause this problem.

B☐ Check the transmitter for excessive non-linear distortion. If the problem is caused by non-linear distortion in the transmitter and the transmitter is working as well as expected for its type, reducing modulation may cure the problem.

C☐ Check the audio output terminals of OPTIMOD-HF with a spectrum analyzer to determine if OPTIMOD-HF is causing the problem. If so, the most likely cause is an overdriven safety clipper (on Card #7) caused by an excessively high setting of R106 (GAIN) in the Hilbert-Transform clipper (on Card #5). See step 15 on page 2-21.

11) If the output frequency balance doesn't sound like the input:

A☐ This is not a fault; it is a consequence of OPTIMOD-HF's processing the audio to make best use of the characteristics of HF propagation and typical HF receivers.

The output frequency balance is not supposed to match the input frequency balance. The multi-band limiter tends to act as an "automatic equalizer", dynamically changing the frequency balance of program material to make it more pleasing and intelligible on a typical HF radio. The thresholds of the multi-band limiter have been set to provide dynamic high-frequency boost. The bass is limited dynamically to prevent various undesirable side-effects, including shortened power tube life in transmitters, excessive IM distortion in the Hilbert-Transform clipper, and excessive distortion in envelope detectors under conditions of selective fading. OPTIMOD-HF will never allow highly exaggerated bass boost, regardless of the setting of its BASS EQ control.

12) If voice sounds too loud:

A☐ For a balance favoring music, train the operators to peak voice at approximately the same point as music on the console meters (if PPMs are used), and *lower* than music (if VU meters are used).

9105A processing is designed to make wide-band, high-quality voice sound somewhat louder than music. Conversely, *narrow-band* voice (like telephone-quality speech) will sound somewhat less loud because

it cannot be clipped as hard as wide-band voice without adding audible distortion, and thus is purposely reduced in level by the processing to avoid such distortion.

13) If there is insufficient high frequency response:

Bear in mind that HF broadcast is usually limited to an upper cutoff frequency of 4.5kHz, and thus *cannot* sound "high fidelity" by any contemporary standard. OPTIMOD-HF has been designed to produce a spectral balance in the 50-4500Hz range that sounds pleasant and well-balanced through a "typical" HF radio, despite the intrinsic bandwidth limits of the channel.

The 9105A's high-frequency equalizer has purposely been limited in range. Further high-frequency boost would cause radios to become unacceptably difficult to tune, and would increase distortion to disturbing levels.

A☐ Verify that your transmitter and antenna have adequate bandwidth.

If not, there will often be high frequency distortion as well.

14) If you hear subtle to moderate distortion:

A☐ Make sure that the distortion is not being caused by the program material itself, or by other components in the audio chain (including the STL).

See step 1. For a discussion about maintaining audio quality at your station, see our publication *Audio Quality in the AM Plant.*

B☐ If the distortion is more moderate than subtle, check the possible causes of severe distortion given in step 15.

C☐ Check that the 9105A's CLIPPING and HILBERT CLIPPER DRIVE controls are properly set (see Section 3 for information on control settings).

D☐ Check the VCA control circuitry on Card #6.

A failure on Card #6 could cause one or more bands to control modulation solely by multi-band clipping. This is usually indicated by the affected band's gain reduction meter reading "0" at all times.

E☐ Check the distortion-canceling sidechains on Cards #5 and #7.

A failure here is typically indicated by a "gritty" high end with severe sibilance splatter.

F☐ Check your transmitter and antenna system.

Look for inadequate power supply, antenna asymmetry, narrow-band antenna, or saturation of the modulation transformer due to heavy use of OPTIMOD-HF's transmitter equalizer. A discussion of transmitter and antenna system requirements begins on page 1-4.

15) If you hear severe distortion:

A☐ Check the power supply.

See step 2 for power supply tests.

B☐ Look for IC opamp failure by tracing the signal (see step 20-B on page 5-11 for a discussion of this technique).

Acute failure in an audio sidechain (such as IC latch-up) will either misbias the main signal path or add distortion to the main signal, without causing the main signal to disappear.

C☐ Check for failure in clipper-diode bias supplies.

Low bias voltage will cause excessive clipping, and will also result in abnormally low modulation.

Verify the presence of approximately −4.1V DC at pin 7 of IC9 on Card #7, and of approximately −1.8V DC at pin 7 of IC10 on Card #7.

D☐ Check 1C7a and IC8 on Card #7.

Failure of these ICs will either misbias the main signal path or add distortion to the main signal without causing the main signal to disappear.

E☐ Check multi-band limiter circuitry.

Failure of one or more bands can cause distortion to be injected into the signal path from the defective band. Because other bands are still operating normally, signal passage will still occur (although with strange frequency response). Faults could occur in the pre-compressor crossovers on Card #4, in the band VCAs on Cards #2 and #3, or in the post-compressor crossover and multi-band clipper on Card #7.

16) For vocal sibilance distortion problems:

A☐ Verify that the source material is undistorted at the 9105A's INPUT terminals.

B☐ Check for failure of the distortion-canceling sidechains on Cards #5 and #7.

C☐ Check the band 5 (3.7kHz) control circuitry on Card #6.

If band 5 is exhibiting no gain reduction, then even a properly-operating distortion-canceling clipper may generate some audible distortion.

17) If sinewave test tones modulate below 100% under normal operating conditions:

This is normal.

The processing is designed to create consistent, natural loudness balances from source to source. Sinewaves have a very low peak-to-average ratio compared to music or speech waveforms. The processing recognizes this, and limits the peak modulation produced by the sinewave to prevent its being substantially louder than other program material.

In addition, to accommodate the additional distortion-cancellation signal produced when the Hilbert-Transform clipper is processing dynamic program material, 10% extra "headroom" is left above the steady-state output level limit of the Hilbert-Transform clipper. So even when the HILBERT CLIPPER DRIVE control is advanced to the point where a sinewave causes gain reduction in the Hilbert-Transform clipper, a sinewave will still produce only about 90% modulation.

18) If the GATE light is behaving abnormally:

This probably indicates a failure of the gating circuitry on Card #6.

19) If you hear pumping or other dynamic audio problems:

The multi-band limiter within the 9105A will not produce natural-sounding audio if the audio presented to it has been processed with a typical wide-band limiter or compressor with a relatively fast attack time (500µs to 20ms). If you wish to place an AGC circuit ahead of the 9105A, it *must* have an attack time of approximately 200ms to achieve natural sound. The 9105A's own broad-band AGC has such an attack time, as does the Orban Model 464A "Co-Operator" when operated in its "leveling" mode. This is why the Model 464A is recommended if you need an AGC ahead of the 9105A (see page 2-8).

The timing circuitry on Card #6 may be faulty. Factory service is recommended (some of this circuitry is contained in sealed modules).

20) If you have not yet identified the cause of the fault:

A☐ Do the "Field Audit of Performance" on page 4-11. Record the results of each test.

B☐ Locate the faulty circuit or component by tracing the signal from the 9105A's input to its output.

If the signal is normal at one point in the circuit, but is abnormal at another point nearer the output, the problem lies in circuitry between the two points. Refer to the block diagram (page 6-47), the circuit description (page 6-5), and the schematic and assembly drawings (page 6-46) for detailed information about 9105A circuitry.

Signal tracing can be performed subjectively or quantitatively. For the former, drive the 9105A with normal program material and listen through an amplifier connected to appropriate points in the circuitry. Quantitative analysis requires a signal generator and oscilloscope or spectrum analyzer. Be aware that some 9105A faults can not be diagnosed using sine wave excitation (see page 6-16).

21) If you *still* have a problem:

Contact Orban Customer Service — see page 5-14.

Components: Fault Diagnosis, Replacement

If you want to troubleshoot on the component level instead of returning the unit to the factory for service, read the circuit description in Section 6 before continuing. Servicing on the component level requires a deeper understanding of 9105A circuitry.

Here are some suggestions for component-level troubleshooting:

IC Opamps:

IC opamps are operated such that the characteristics of their associated circuits are essentially independent of IC characteristics and dependent only on external feedback components. The feedback forces the voltage at the − input terminal to be extremely close to the voltage at the + input terminal. Therefore, if you measure more than a few millivolts difference between these two terminals, the IC is probably bad.

Exceptions are ICs used without feedback (as comparators) and ICs with outputs that have been saturated due to excessive input voltage because of a defect in an earlier stage. However, if an IC's + input is more positive than its − input, yet the output of the IC is sitting at −14 volts, the IC is almost certainly bad. The same holds true if the above polarities are reversed. Because the characteristics of the 9105A's circuitry are essentially independent of IC opamp characteristics, an opamp can usually replaced without recalibration. The dual current-controlled gain blocks employed in the VCAs (IC2, IC5, IC7 and IC12 on Cards #2 and #3), and the multiplier/dividers on Card #5 (IC13 and IC17) are ***not*** opamps. If these chips are replaced, calibration is *absolutely necessary*.

A defective opamp may appear to work, yet have extreme temperature sensitivity. If parameters appear to drift excessively, freeze-spray may aid in diagnosing the problem. Freeze-spray is also invaluable in tracking down intermittent problems. But *use it sparing*, because it can cause resistive short circuits due to moisture condensation on cold surfaces.

Output module failure:

The 5532 and 411 opamps used in the balanced output module on Card #8 may be freely replaced as necessary. However, the circuit is extremely sensitive to the characteristics of the resistors, so field repair of resistor failure (which is very unlikely) requires replacement of the entire output module in question if adequate headroom and common-mode rejection are to be maintained (see 5-14 for information about factory service).

Selecting Replacement Parts:

Before ordering parts, read the introduction to the parts list on page 6-30. Nearly all parts used in the 9105A have been very carefully chosen to make best use of both major and subtle characteristics. For this reason, parts should always be replaced with *exact duplicates* if so indicated in the parts list. It is very risky to make "close-equivalent" substitutions because of the possibility of altering performance and/or compliance with regulatory requirements.

Certain parts are selected to tighter than normal specifications (most such parts are noted in the parts list — but it is almost always wiser to return the defective card to the factory for service). The replacement of certain parts requires partial recalibration of the 9105A, and this may or may not be practical in the field (such parts are also noted in the parts list). Some cards have potted modules which must be replaced as a unit (ordinarily, this requires return of the entire card to the factory).

To replace a component:

It is important to use correct technique when replacing components mounted on printed circuit cards. Failure to do so may result in circuit damage and/or intermittent problems. Because solder flows well into the through-holes of the double-sided plated-through circuit boards used in the 9105A, a technique like the following is required.

1) Remove the old component.

It is sometimes easier to cut the offending components from its leads, then remove the leads as described below.

A☐ Clear each lead to be removed by melting the solder *on the solder side* (underneath) of the printed circuit card. When the solder melts, vacuum it away with a spring-actuated de-soldering tool (like the Edsyn Soldapullt®).

Use a **30-watt soldering iron** — do *not* use a soldering gun or a high-wattage iron! DO NOT OVERHEAT the card. Overheating will almost surely cause the conductive foil to separate from the card base.

B☐ Release the component by gently wiggling each of the leads to break solder webs, then lift the component out.

2) Install the new component.

A☐ Bend the leads of the replacement component so they will fit easily into the appropriate circuit card holes.

B☐ Solder each lead to the bottom side of the card.

Use a 30-watt soldering iron and a good brand of *rosin-core* solder. Make sure that the joint is smooth and shiny.

If no damage was done to the plated-through hole when the old component was removed, soldering of the top (component side) pad is not necessary. But if the removal procedure did not progress smoothly, it would be prudent to solder each lead on the component side of the hole to avoid potential problems.

C☐ Cut each lead of the replacement component close to the solder side of the circuit card with a pair of diagonal cutters.

D☐ Remove all residual flux with a swab moistened with solvent.

Suitable solvents include 99% isopropyl alcohol, 1,1,1-trichloroethane (sold as Energine® Fireproof Cleaning Fluid), and naphtha (sold as Energine® Regular Cleaning Fluid).

Make sure that the flux has actually been removed, and not just made less visible by smearing. While most rosin fluxes are not corrosive, they can slowly absorb moisture and become sufficiently conductive to degrade circuit performance.

Technical Support, Service

If the troubleshooting information in this manual doesn't help you solve your problem, contact Orban Customer Service. Be prepared to accurately describe the problem, including the results of diagnostic tests you have performed. Know the serial number (and "M" number, if any) of your 9105A — these are printed on a label attached to the rear panel of the 9105A.

Always contact Customer Service before returning a product to the factory for service. Often, a problem is due to misunderstanding, or is relatively simple and can be quickly fixed after telephone consultation. In any case, products will be accepted for factory service *only* after Customer Service has issued a Return Authorization number. This number flags the returned 9105A for priority treatment when it arrives on our dock, and ties it to the appropriate information file.

Telephone: (1) 415/351-3500

or Fax: (1) 415/351-0500

or Write: Customer Service
Orban
1525 Alvarado Street
San Leandro, CA 94577 USA

To ship a circuit card, use the special carton in which Orban shipped you the loaner card. Do not use a padded mailer — it will not provide sufficient protection.

To ship the complete 9105A, use the original packing material if it is available. If it is not, use a sturdy, double-wall carton no smaller than 22 × 15 × 12 inches (56 × 38 × 30 cm) with a minimum bursting test rating of 200 pounds (91 kg). Place the chassis in a plastic bag (or wrap it in plastic) to protect the finish, then wrap cushioning material around it. Do not pack the 9105A in crumpled newspaper — use bubble sheets, large foam beads, thick fiber blankets, or similar packing materials. Put at least 2 inches (5 cm) of cushioning on all sides of the 9105A, and tape the cushioning in place to prevent shifting during shipment. Close the carton without sealing it and shake it vigorously (if you can hear or feel the 9105A move, use more packing). Seal the carton with 3-inch (8cm) reinforced fiberglass or polyester sealing tape (narrow or paper tapes won't hold), top and bottom in an H pattern. Mark the package with the name of the shipper, and with these words in red:

DELICATE INSTRUMENT, FRAGILE!

Insure the package appropriately. Ship prepaid, *not collect.* Do not ship parcel post. Your Return Authorization number must be shown on the label, or the package will *not* be accepted.

The terms of the Orban Associates Limited One-Year Standard Warranty are detailed on a separate Warranty Certificate supplied with the 9105A. After expiration of the warranty, a reasonable charge will be made for parts, labor, and packing if you choose to use the factory service facility. The repaired 9105A will be returned C.O.D. In all cases, transportation charges (which are usually quite nominal) are paid by the customer.